PATENT ABSTRACTS OF JAPAN

(11)Publication number : **07-128619**
(43)Date of publication of application : **19.05.1995**

(51)Int.Cl.

G02B 27/64
G02B 7/02
G02B 13/18
G02B 15/00
G02B 15/16
G03B 5/00

(21)Application number : **05-298955**
(22)Date of filing : **04.11.1993**

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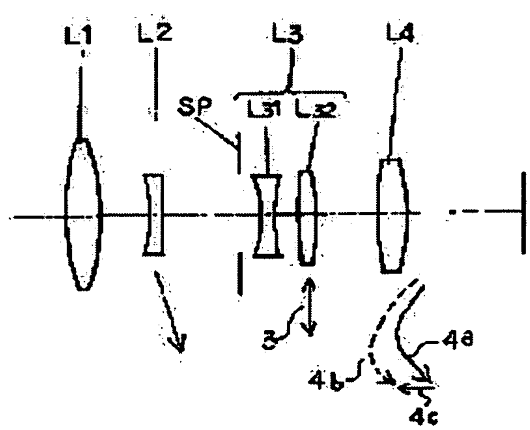
(54) VARIABLE POWER OPTICAL SYSTEM HAVING VIBRATIONPROOF FUNCTION

(57)Abstract:
PURPOSE: To provide the variable power optical system which is constituted to form a static image by optically correcting the blur of the photographic image in the event of vibration of the variable power optical system and has a vibrationproof function.
CONSTITUTION: This variable power optical system has, successively from an object side, four lens groups; a first group L1 which is stationary at the time of varying power and focusing and has a positive refracting power, a second group L2 which has a variable power function and has a negative refracting power, a third group L3 which has a aperture diaphragm and a positive refracting power and a fourth group L4 which has both of a correction function to correct the image plane fluctuated by the variable power and a focusing function and has a positive refracting power. The third group L3 consists of two lens groups; a 31st group L31 having a negative refracting power and a 32nd group L32 having a positive refracting power and corrects the blur of the photographic image when the variable power optical system vibrates by moving the 32nd group L32 in a direction perpendicular



to the optical axis.

CLAIMS

[Claim(s)]
[Claim 1]The 1st group of positive refracting power of immobilization [side / object / in order] in the case of variable power and a focus, the 2nd group of negative refracting power that has a variable power function, It is a variable power optical system with four lens groups of the 4th group of positive refracting power that has a function of an aperture diaphragm, the 3rd group of positive refracting power, and both sides of a correcting function which amends the image surface changed by variable power, and a focus function, A variable power optical system with a vibration proof function, wherein this 3rd group has amended Bure of a taken image when two lens groups, the 31st group of negative refracting power and the 32nd group of positive refracting power, are comprised, this 32nd group is moved to an optic axis and a perpendicular direction and this variable power optical system vibrates.
[Claim 2]A variable power optical system with a vibration proof function of claim 1 satisfying conditions which become $1.5<|f31-/f32|<2.5$ when a focal distance of said 31st group and the 32nd group is respectively set to f31 and f32.
[Claim 3]The 1st group of positive refracting power of immobilization [side / object / in order] in the case of variable power and a focus, the 2nd group of negative refracting power that has a variable power function, It is a variable power optical system with four lens groups of the 4th group of positive refracting power that has a function of the 3rd group of positive refracting power, and both sides of a correcting function which amends the image surface changed by variable power, and a focus function, A variable power optical system with a vibration proof function, wherein this 3rd group has amended Bure of a taken image when it has two or more lens groups, at least some lens groups in this 3rd group are moved to an optic axis and a perpendicular direction and this variable power optical system vibrates.
[Claim 4]A variable power optical system with a vibration proof function of claim 3, wherein said 3rd group has two lens groups, the 31st group of positive refracting power, and the 32nd group of negative refracting power, and is moving this 32nd group to an optic axis and a perpendicular direction.
[Claim 5]A variable power optical system with a vibration proof function of claim 3 satisfying conditions which become $0.8<|f31-/f32|<1.0$ when a focal distance of said 31st group and the 32nd group is respectively set to f31 and f32.
[Claim 6]Claims 3 and 4 providing an aperture diaphragm near said 3rd group, or a variable power optical system with a vibration proof function of 5.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]In this invention, some especially lens groups of a variable power optical system are moved to an optic axis and a perpendicular direction about a variable power optical system with a vibration proof function.
Therefore, it is related with a variable power optical system with the suitable vibration proof function for a photographic camera, a video camera, etc. which amended optically Bure of the taken image when this variable power optical system vibrates (tilting), obtained the still picture, and attained stabilization of the taken image.

[0002]
[Description of the Prior Art]If it is going to carry out photography from on [, such as an on-going car, an airplane, etc.,] a movable matter object, vibration will get across to a photographing system, it will become a shaking hand, and Bure will arise in a taken image.
[0003]The vibration-proof optical system with the function to prevent Bure of the taken image at this time conventionally is proposed [that it is various and].
[0004]For example, in JP,56-21133,B, stabilization of the picture is attained by moving an optical apparatus in the direction which offsets oscillating displacement of the picture according some optical members to vibration according to the output signal from a detection means to detect a vibrational state.
[0005]In JP,61-223819,A, in the photographing system which has arranged the refracted type variable vertex angle prism to the photographic subject side most, it is made to correspond to vibration of a photographing system, the vertical angle of this refracted type variable vertex angle prism is changed, a picture is deflected, and stabilization of the picture is attained.
[0006]In JP,56-34847,B and JP,57-7414,B, the fixed optical member has been spatially arranged to vibration to a part of photographing system, by using the prism action produced to vibration of this optical member, the taken image was deflected and the still picture has been obtained on the image formation face.
[0007]In JP,1-116619,A or JP,2-124521,A, vibration of a photographing system is detected using an acceleration sensor etc., and the method of obtaining a still picture is also performed by vibrating some lens groups of a photographing system in the direction which intersects perpendicularly with an optic axis according to the signal acquired at this time.
[0008]In addition, when the lens system which comprises two lens groups of negative, the 1st group of positive refracting power, and the 2nd group in JP,2-238429,A or U.S. Pat. No. 2959088 is arranged ahead of a photographing system and a photographing system

vibrates, This 2nd group was made into the operation lens group for vibration proof, and the vibration-proof optical system using the inertia pendulum method which carried out gimbal support in the focal position is proposed.
[0009]
[Problem(s) to be Solved by the Invention]There was a problem that the moving mechanism for arranging a vibration-proof optical system ahead of a photographing system generally, vibrating some moving lens groups of this vibration-proof optical system, losing Bure of a taken image, and the whole device enlarging the method of obtaining a still picture, and moving this moving lens group was complicated.
[0010]The yield of the decentration aberration when vibrating a moving lens group increased, and the problem of falling greatly also had optical performance.
[0011]Especially in the optical system which makes vibration-proof using a variable vertex angle prism, there was a problem that the yield of the eccentric chromatic aberration of magnification increased in the long focal length side (looking-far side) at the time of vibration proof.
[0012]Although there is an advantage of not requiring an optical system special for vibration proof, in the optical system which makes vibration-proof on the other hand by making the parallel eccentricity of some lenses of a photographing system carry out perpendicularly to an optic axis, The space for the lens to which it is made to move was needed, and there was a problem that the yield of the decentration aberration at the time of vibration proof increased.
[0013]In order to secure required light volume on an imaging surface at the time of vibration proof, the lens diameter of the lens group by the side of an object had to be made larger than a moving lens group, and there was a problem that the whole device enlarged and came for this reason.
[0014]This invention by moving the comparatively small lightweight lens group which constitutes a part of variable power optical system to an optic axis and a perpendicular direction, and constituting so that Bure of a picture when this variable power optical system vibrates (tilting) may be amended, An eccentric yield when carrying out eccentricity of this lens group is stopped few, attaining miniaturization of the whole device, simplification on a mechanism, and reduction of the load of a driving means, and it aims at offer of a variable power optical system with the vibration proof function which amended the decentration aberration good.
[0015]
[Means for Solving the Problem]The 1st group of refracting power of immobilization [side / object (1-1) / in order] in the case of variable power and a focus positive in a variable power optical system with a vibration proof function of this invention, The 2nd group of negative refracting power that has a variable power function, an aperture diaphragm, the 3rd group of positive refracting power, And it is a variable power optical system with four lens groups of the 4th group of positive refracting power that has a function of both sides of a correcting function which amends the image surface changed by variable power, and a focus function, It is characterized by this 3rd group having amended Bure of a taken image when two lens groups, the 31st group of negative refracting power and the 32nd group of positive refracting power, are comprised, this 32nd group is moved to an optic axis and a perpendicular direction and this variable power optical system vibrates.
[0016](1-2) The 1st group of positive refracting power of immobilization [side / object / in order] in the case of variable power and a focus, It is a variable power optical system with four lens groups of the 4th group of positive refracting power that has a function of the 2nd group of negative refracting power that has a variable power function, the 3rd group of positive refracting power, and both sides of a correcting function which amends the image surface changed by variable power, and a focus function, It is characterized by

this 3rd group having amended Bure of a taken image when it has two or more lens groups, at least some lens groups in this 3rd group are moved to an optic axis and a perpendicular direction and this variable power optical system vibrates.

[0017]

[Example]The schematic diagram, drawing 18, and drawing 19 which drawing 1 shows the paraxial refractive power arrangement of the numerical examples 1-4 which this invention mentions later are a schematic diagram showing the paraxial refractive power arrangement of the numerical examples 5 and 6 which this invention mentions later.

[0018]The lens sectional view of the wide angle end of the numerical examples 1-4 of this invention and drawing 20 of drawing 2 - drawing 5 are the lens sectional views of the wide angle end of the numerical example 5 of this invention.

[0019]In drawing 1, the 1st group of refracting power positive in L1, the 2nd group of refracting power negative in L2, and L3 are the 3rd group of positive refracting power, and it has the 31st group L31 of negative refracting power, and the 32nd group L32 of positive refracting power.

[0020]In numerical examples 1-4, Bure of a taken image when the 32nd group L32 is moved to an optic axis and a perpendicular direction and a variable power optical system vibrates (tilting) is amended.

[0021]L4 is the 4th group of positive refracting power. SP is an aperture diaphragm and is stationed ahead of the 3rd group L3. G is glass blocks, such as a faceplate. IP is the image surface.

[0022]In this example, on the occasion of the variable power from a wide angle end to a tele edge, the 2nd group is moved to the image surface side like an arrow, and the 4th group was moved and the image surface fluctuation accompanying variable power is amended.

[0023]The rear focus type which moves the 4th group on an optic axis and performs a focus is adopted. The curve 4a of the solid line of the 4th group and the curve 4b of a dotted line which are shown in the figure show the moving track for amending the image surface fluctuation at the time of following on the variable power from a wide angle end when carrying out the focus to the infinite distance object and the short distance object respectively to a tele edge. The 1st group and the 3rd group are immobilization in the case of variable power and a focus.

[0024]In this example, move the 4th group and the image surface fluctuation accompanying variable power is amended, and the 4th group is moved and it is made to perform a focus. It is made to move so that it may have a convex locus to the object side on the occasion of the variable power from a wide angle end to a tele edge, as shown especially in the curves 4a and 4b of the figure. This aimed at effective use of the space of the 3rd group and the 4th group, and shortening of whole length of the lens is attained effectively.

[0025]In this example, when performing a focus from an infinite distance object to a short distance object in a tele edge, it is carrying out by letting out the 4th group to the front, as shown in the straight line 4c of the figure.

[0026]The zoom lens in this example has taken the zooming system which carries out image formation of the virtual image formed by the constructional system of the 1st group and the 2nd group on a sensitization side by the 3rd group and the 4th group.

[0027]In this example, the increase of the lens effective diameter of the 1st group is prevented effectively, preventing the performance degradation by the eccentric error of the 1st group by taking the above rear focus methods compared with the case where let out the 1st group in what is called a conventional 4 group zoom lens, and a focus is performed.

[0028]And by arranging an aperture diaphragm just before the 3rd group, the aberration

variation by a moving lens group was lessened, and reduction-ization of a front ball lens diameter is easily attained by making the interval of a front lens group shorter than an aperture diaphragm.
[0029]Image Bure when constitute the 3rd group L3 from two lens group L3-1 and L3-2 in the numerical examples 1-4 of this invention, among these it is made to move to an optic axis and a perpendicular direction by having made the 32nd group L32 vibration proof and a variable power optical system vibrates is amended. It is making vibration-proof without this newly adding optical members, such as a lens group for vibration proof, and a variable vertex angle prism, compared with the conventional vibration-proof optical system.
[0030]Next, the optical principle of the vibration-proof system which moves a lens group to an optic axis and a perpendicular direction in the variable power optical system concerning this invention, and amends Bure of a taken image is explained using drawing 27.
[0031]As shown in drawing 27 (A), the optical system consists of three portions of fixed group Y1, the eccentric group Y2, and the fixed group Y3, and it is assumed that the object point P on the optic axis which is fully separated from a lens is carrying out image formation to the center of imaging surface IP as the image point p.
[0032]Supposing the whole optical system including imaging surface IP inclines momentarily by a shaking hand like drawing 27 (B) now, the object point P will move to image point p' momentarily too, and will serve as the Bure ******.
[0033]On the other hand, when the eccentric group Y2 is moved to an optic axis and a perpendicular direction, like drawing 27 (C), the image point p moves to p ", and its movement magnitude and direction are expressed as eccentric sensitivity of the lens group depending on power arrangement.
[0034]Then, hand shake correction, i.e., vibration proof, is performed as image point p' which shifted by the shaking hand in drawing 27 (B) is shown in drawing 27 (D) by returning to the image formation position p of a basis when only a suitable quantity moves the eccentric group Y2 to an optic axis and a perpendicular direction.
[0035]Now, the vibration-proof capability in the meaning of shifting a picture will be called vibration-proof sensitivity IS, [Shift amount mm / correction angle deg] It expresses with the unit to say. When eccentric sensitivity of f and the shift group Y2 is set to TS for the focal distance of a master lens, vibration-proof sensitivity IS is IS=f-tan1"/TS...... (a)
It comes out, and it is expressed and the eccentric sensitivity which the shift group has serves as important factor.
[0036]In the variable power optical system concerning this invention, the light which usually emitted the 3rd group L3 is an abbreviated parallel beam. For this reason, eccentric sensitivity TS serves as a very small value.
[0037]Then, in the numerical examples 1-4 of this invention, the 3rd group is constituted from two lens groups, the 31st group L31 of negative refracting power, and the 32nd group L32 of positive refracting power, eccentric sensitivity TS is enlarged, and it enables it to make vibration-proof effectively.
[0038]When the focal distance of the 31st group and the 32nd group is set to f31 and f32 especially in the numerical examples 1-4, respectively, it is 1.5<|f31/f32|<2.5...... (1-1)
It is made to be satisfied.
[0039]A conditional expression (1-1) is related with the refractive power arrangement of two lens groups of the 3rd group. if the negative refracting power of the 31st group becomes weak exceeding the upper limit of a conditional expression (1-1), the effect which divided the 3rd group is small, eccentric large sensitivity cannot be taken, and it becomes difficult to secure the space which puts in a driving means for the 32nd group between the 32nd group and the 4th group, and it is not preferred.

[0040]Conversely, if the negative refracting power of the 31st group becomes strong too much exceeding the lower limit of a conditional expression (1-1), In order to maintain the 3rd group at positive refracting power as a whole, according to it, the refracting power of the 32nd group become strong too much and. When leading to optical performance degradation at the time of vibration proof, and the eccentric sensitivity of the 32nd group becomes high too much and it performs closed loop control using the Bure correction amount from each speed sensor also from on vibration-proof control, an oscillation, the amendment remainder, etc. of a control system come out, and it is not desirable.
[0041]Next, the numerical examples 5 and 6 of this invention are described using drawing 18 and drawing 19.
[0042]The numerical examples 5 and 6 constitute the 3rd group of positive refracting power from two or more lens groups, as shown in drawing 18 compared with the numerical examples 1-4, Among these, it differs in that Bure of a taken image when at least one lens group L3a is moved to an optic axis and a perpendicular direction and a variable power optical system vibrates (tilting) is amended, and other composition is the same.
[0043]As specifically shown in drawing 19, the 3rd group is constituted from the 31st group L31 of positive refracting power, and the 32nd group L32 of negative refracting power in order from the object side, The point of moving this 31st group to the optic axis and the perpendicular direction differs from the conditional expression (1-2) which restrict the ratio of the focal distance of the 31st group and the 32nd group and which is mentioned later, and other composition is the same.
[0044]In drawing 18 and drawing 19, the same code number is given to the same element as drawing 1.
[0045]The optical principle of the vibration-proof system which amends Bure of a taken image in the variable power optical system of the numerical examples 5 and 6 which have the paraxial refracting power shown in drawing 19 is the same as drawing 27 fundamentally mentioned above.
[0046]It is set up so that the light flux which emitted the 3rd group L3 like the numerical examples 1-4 mentioned above in the numerical examples 5 and 6 may become an abbreviated parallel beam. For this reason, the eccentric sensitivity of the 3rd group L3 serves as a very small value.
[0047]Then, as the numerical examples 5 and 6 are shown in drawing 19, the 3rd group L3 is divided into the 31st group of positive refracting power, and the 32nd group of negative refracting power, this raises the eccentric sensitivity of the 31st group, and it enables it to make vibration-proof effectively.
[0048]When the focal distance of the 31st group and the 32nd group is set to f31 and f32 in the numerical examples 5 and 6, respectively, it is $0.8<|f31/f32|<1.0$...... (1-2)
It is made to be satisfied.
[0049]The effect of a conditional expression (1-2) which divided the 3rd group when it is related with refracting power distribution of the lens group which constitutes the 3rd group and the negative refracting power of the 32nd group became weak exceeding the lower limit of a conditional expression (1-2) is small, and eccentric large sensitivity cannot be taken.
[0050]Conversely, if the negative refracting power of the 32nd group becomes strong too much exceeding the upper limit of a conditional expression (1-2), in order to maintain the 3rd group at positive refracting power as a whole, according to it, the positive refracting power of the 31st group become strong too much and. When it leads to the performance degradation at the time of vibration proof, and the eccentric sensitivity of the 31st group becomes high too much and closed loop control is performed also from a point of vibration-proof control using the signal acquired, for example from the amount detection

means of shaking hands, the oscillation of a control system is not caused, or Bure's amendment remainder etc. arise and it is not desirable.
[0051]In numerical examples 1-4, both lens sides constitute the 31st group from two lenses of the positive lens and negative lens on the meniscus which turned the convex to the concave single lens [negative] or object side, and the 32nd group consists of lamination lenses which joined the positive lens, the positive lens, and the negative lens.
[0052]The 31st group is constituted from the lamination lens and positive lens which joined the positive lens and the negative lens, and the 32nd group consists of the numerical examples 5 and 6 from two negative lenses.
[0053]Generating of a decentration aberration when moving the lens group for vibration proof to an optic axis and a perpendicular direction by this is lessened, and the optical performance of the whole screen is maintained good.
[0054]Next, the numerical example of this invention is shown. in a numerical example -- Ri -- the object side -- it is a curvature radius of the i-th lens side, and, as for Di, the i-th lens thickness and air spacing, nickel, and nui are the refractive index and Abbe number of glass of the i-th lens in order from the each object side in the object side. The relation between the above-mentioned monograph affair type and many numerical values in a numerical example is shown in table-1.
[0055]When aspherical surface shape makes positive the direction of movement of H axis and light to the X-axis, an optic axis, and a perpendicular direction at an optical axis direction and a paraxial curvature radius, A, B, C, D, and E are respectively made into an aspheric surface coefficient for R [0056]
[Equation 1]

$$X=\frac{(1/R)\,H^2}{1+\sqrt{1-(H/R)^2}}+AH^2+BH^4+CH^6+DH^8+EH^{10}$$

It expresses with the becoming formula.
[0057]<The numerical example 1> F = 1.0-10.0. fno=1:1.85 - 2.28 2omega=46.81 degree-6.08 degree R 1= 17.935 D 1= 0.304 N 1=1.80518 nu 1= 25.4 R 2= 4.321 D 2= 1.673 N. 2=1.62299 nu 2= 58.2. R 3=-16.760 D 3= 0.043. R 4= 3.684 D 4= 0.956. N 3=1.72000 nu 3= 50.3. R 5= 9.957D5 = variable R. 6=-62.802 D 6= 0.108. N 4=1.77250 nu 4= 49.6. R 7= 0.975 D 7= 0.541. R 8=-3.053 D 8= 0.108. N 5=1.69680 nu 5= 55.5. R 9= 1.075 D 9= 0.608. N 6=1.84666 nu 6= 23.8. R10=-682.845 D10 = variable R11= (diaphragm) D11= 0.434 R12=-6.171 D12= 0.130 N 7=1.60311 nu 7= 60.7 R13= 5.553 D13= 0.434 R14= 4. . 532 D14= 0.717 N 8=1.60311. nu 8= 60.7 R15=-2.632. D15= 0.032 R16= 3.554. D16= 0.978 N 9=1.60311. nu 9= 60.7 R17=-1.752. D17= 0.152 N10=1.83481. nu10= 42.7 R18=-308.466. D18 = Variable R19= 56.092 D19=. 0.108 N11=1.80518 nu11=. 25.4 R20= 2.492 D20=. 0.760 N12=1.48749 nu12=. 70.2 R21=-2.787 D21=. 0.032 R22= 2.430 D22= 0.391 N13=1.48749 nu13= 70.2 R23= 7.801 D23= 0.500 R24= infinity D24= 0.869 N14=1.51633 nu14= 64.2 R25= infinity[0058]

DESCRIPTION OF DRAWINGS

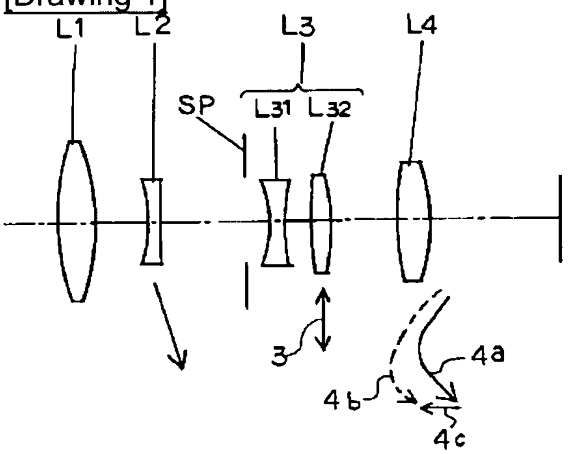
[Brief Description of the Drawings]
[Drawing 1]The schematic diagram of the paraxial refractive power arrangement of the variable power optical system concerning this invention
[Drawing 2]The lens sectional view of the wide angle end of the numerical example 1 of this invention
[Drawing 3]The lens sectional view of the wide angle end of the numerical example 2 of this invention
[Drawing 4]The lens sectional view of the wide angle end of the numerical example 3 of this invention
[Drawing 5]The lens sectional view of the wide angle end of the numerical example 4 of this invention
[Drawing 6]The several aberration figure of the wide angle end of the numerical example 1 of this invention
[Drawing 7]The several aberration figure of the tele edge of the numerical example 1 of this invention
[Drawing 8]The several aberration figure of the tele edge of the numerical example 1 of this invention
[Drawing 9]The several aberration figure of the wide angle end of the numerical example 2 of this invention
[Drawing 10]The several aberration figure of the tele edge of the numerical example 2 of this invention
[Drawing 11]The several aberration figure of the tele edge of the numerical example 2 of this invention
[Drawing 12]The several aberration figure of the wide angle end of the numerical example 3 of this invention
[Drawing 13]The several aberration figure of the tele edge of the numerical example 3 of this invention
[Drawing 14]The several aberration figure of the tele edge of the numerical example 3 of this invention
[Drawing 15]The several aberration figure of the wide angle end of the numerical example 4 of this invention
[Drawing 16]The several aberration figure of the tele edge of the numerical example 4 of this invention
[Drawing 17]The several aberration figure of the tele edge of the numerical example 4 of this invention
[Drawing 18]The schematic diagram of the paraxial refractive power arrangement of the variable power optical system concerning this invention
[Drawing 19]The schematic diagram of the paraxial refractive power arrangement of the

variable power optical system concerning this invention
[Drawing 20]The lens sectional view of the wide angle end of the numerical example 5 of this invention
[Drawing 21]The several aberration figure of the wide angle end of the numerical example 5 of this invention
[Drawing 22]The several aberration figure of the tele edge of the numerical example 5 of this invention
[Drawing 23]The several aberration figure of the tele edge of the numerical example 5 of this invention
[Drawing 24]The several aberration figure of the wide angle end of the numerical example 6 of this invention
[Drawing 25]The several aberration figure of the tele edge of the numerical example 6 of this invention
[Drawing 26]The several aberration figure of the tele edge of the numerical example 6 of this invention
[Drawing 27]The explanatory view of the optical principle of the vibration-proof system concerning this invention
[Description of Notations]
L1 The 1st group
L2 The 2nd group
L3 The 3rd group
L4 The 4th group
L31 The 31st group
L32 The 32nd group
SP Diaphragm
IP Image surface
d d line
g g line
deltaM meridional image surface
deltaS sagittal image surface

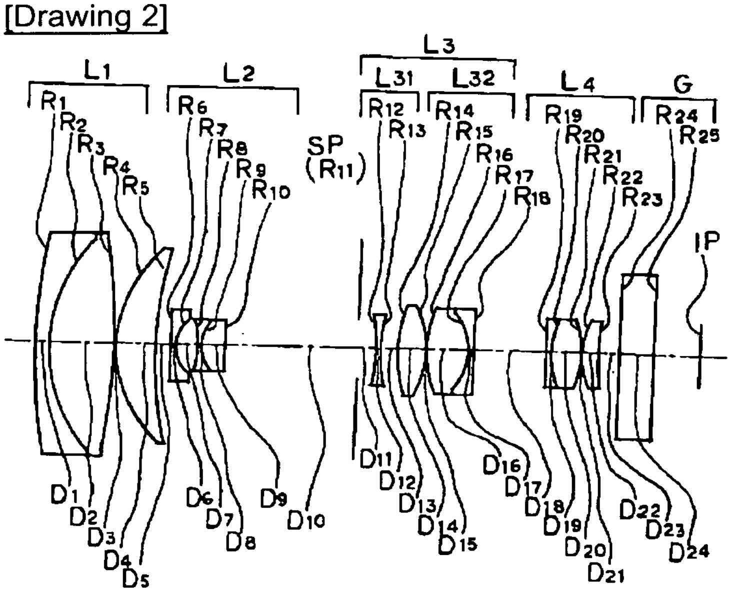
[Translation done.]

DRAWINGS

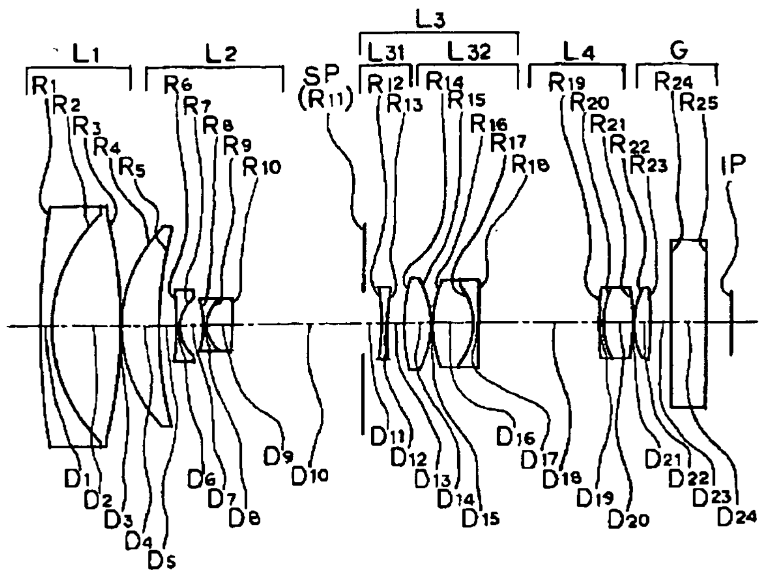
[Drawing 1]



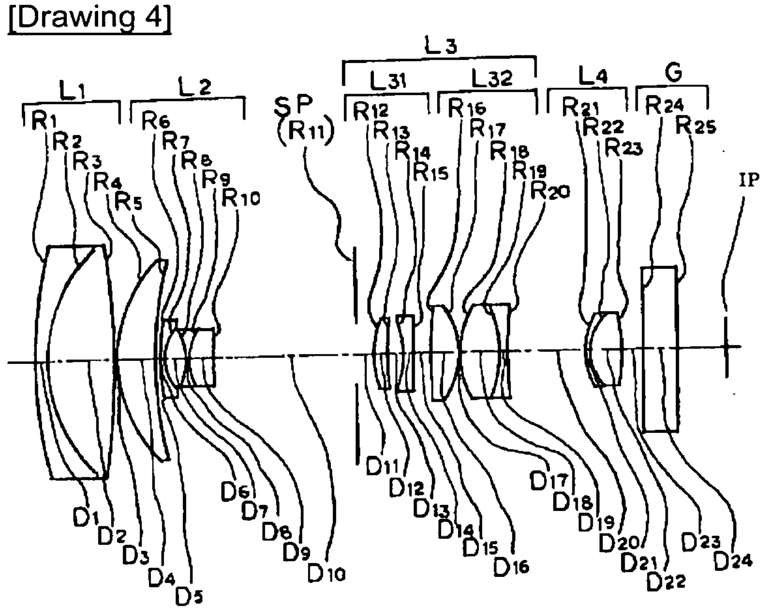
[Drawing 2]



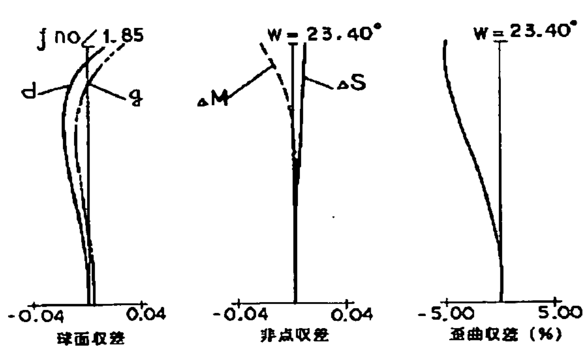
[Drawing 3]



[Drawing 4]



[Drawing 6]



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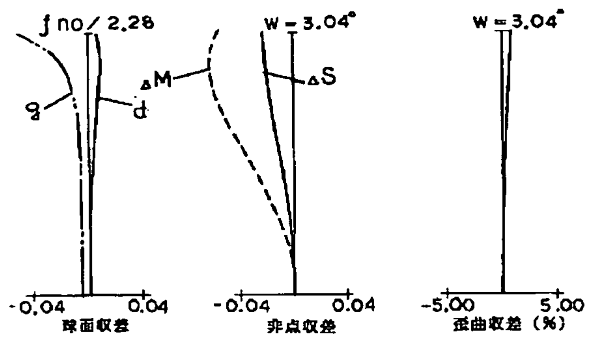
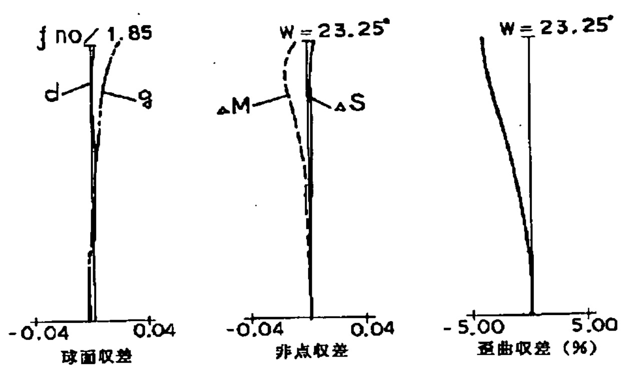
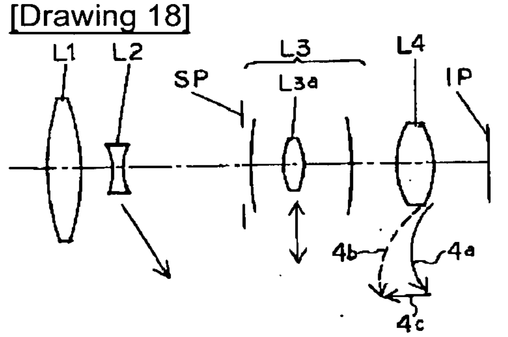


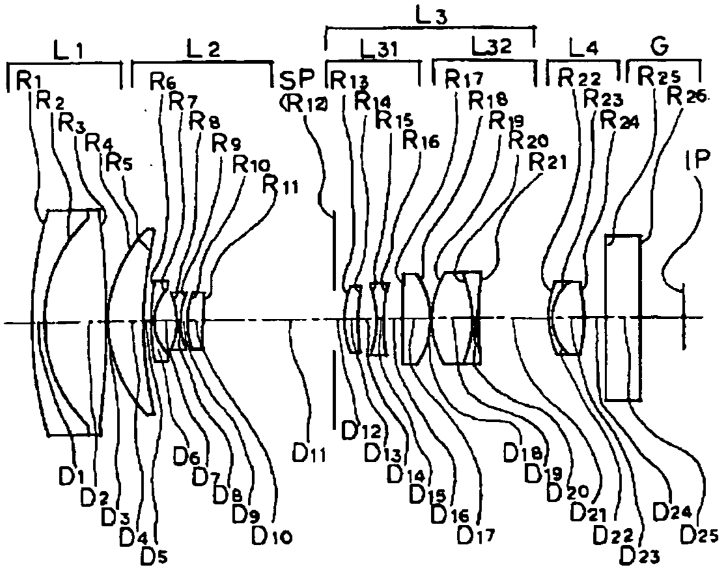
[Drawing 15]



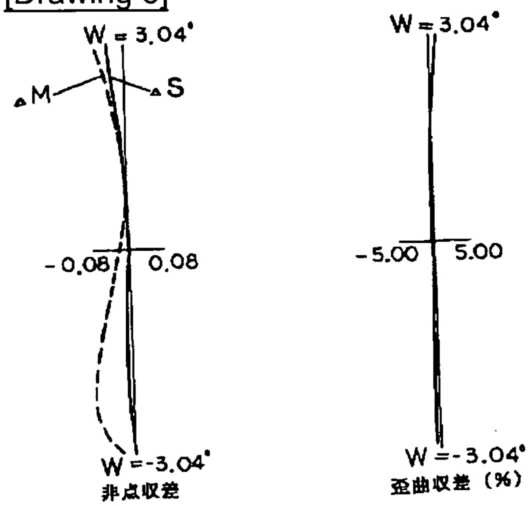
[Drawing 18]



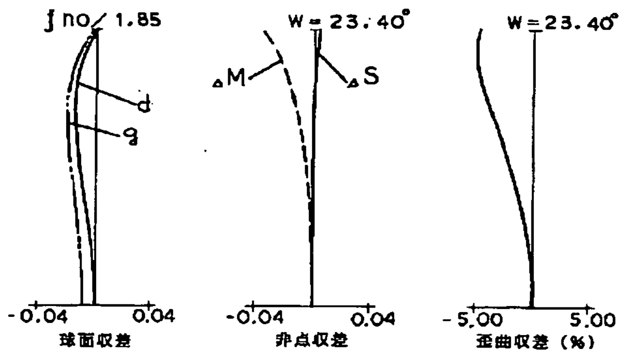
[Drawing 5]



[Drawing 8]



[Drawing 9]



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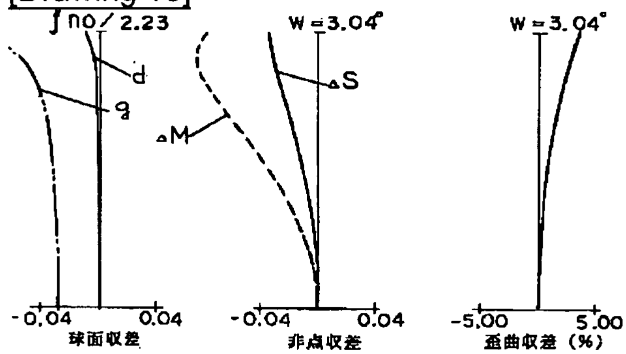

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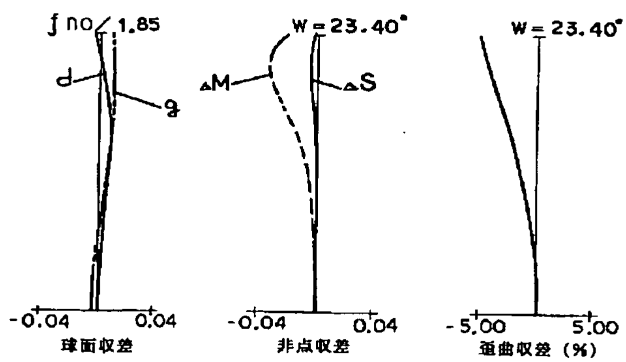
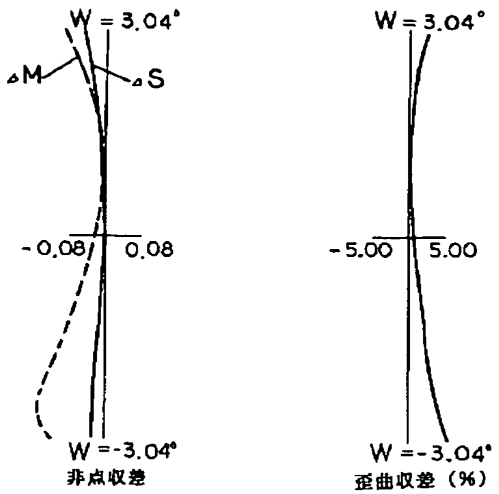


[Drawing 11]



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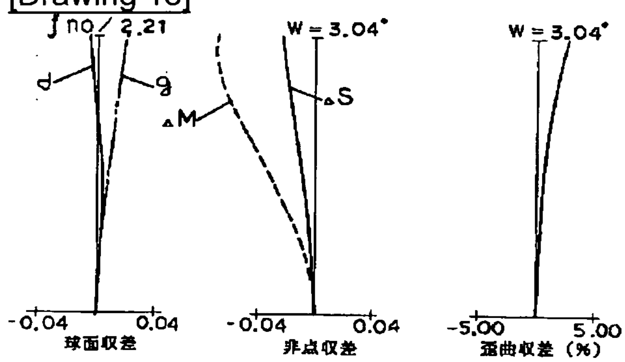

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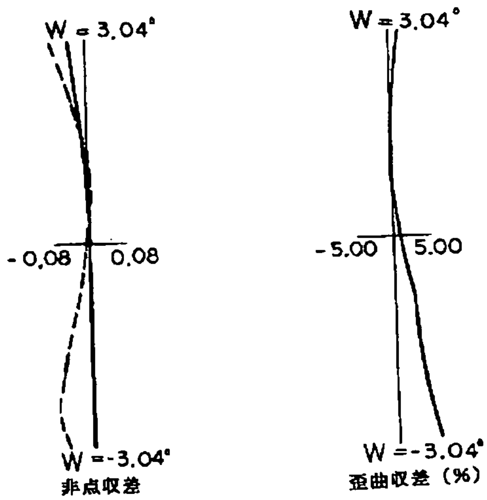

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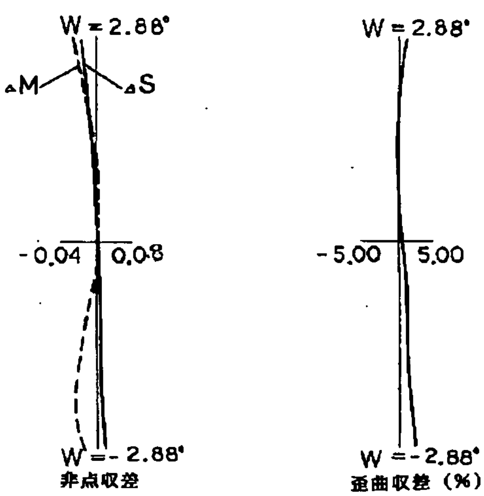
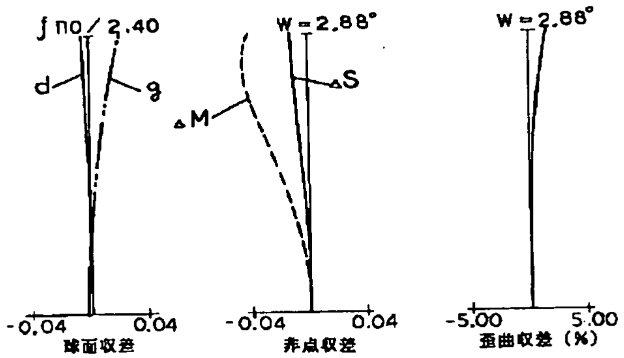
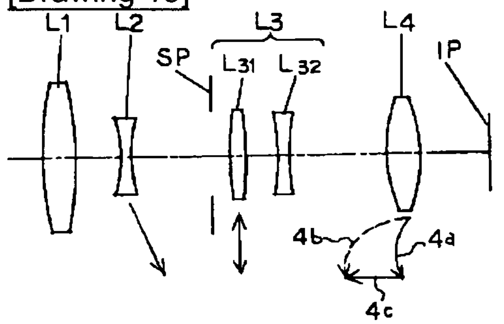


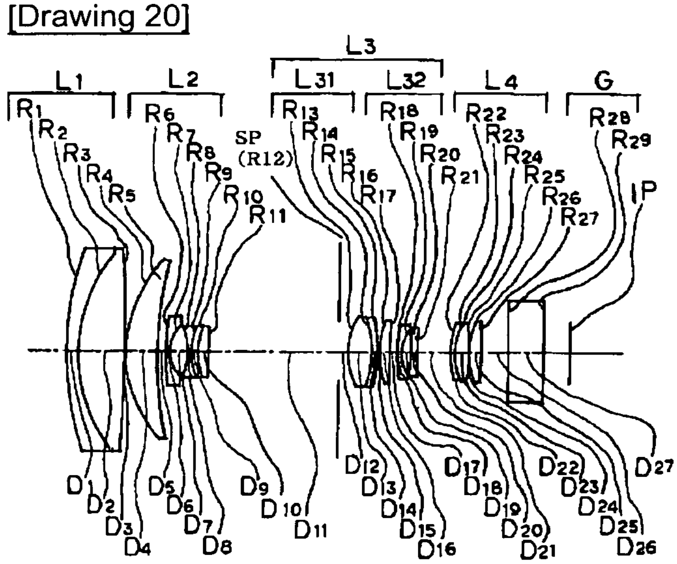
[Drawing 16]



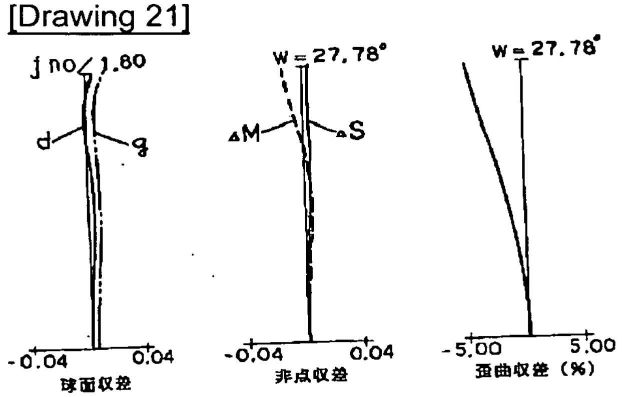
[Drawing 19]



[Drawing 20]



[Drawing 21]



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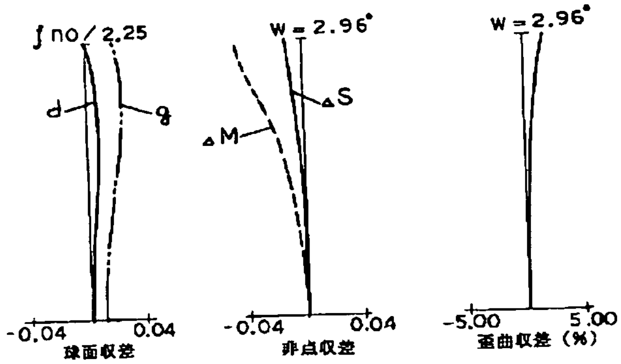

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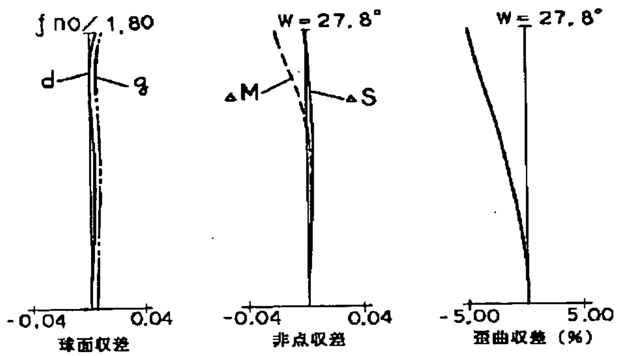
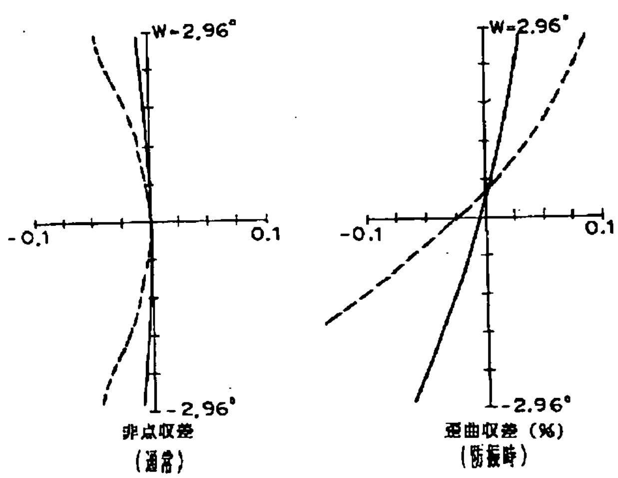


[Drawing 23]



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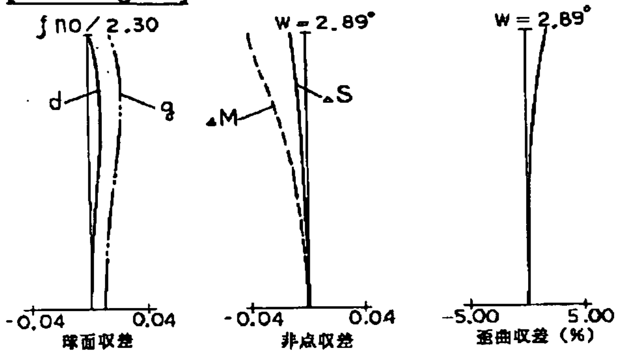

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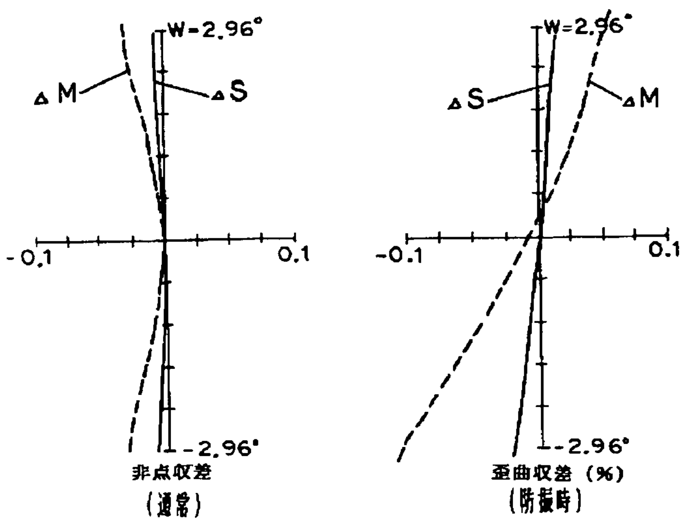

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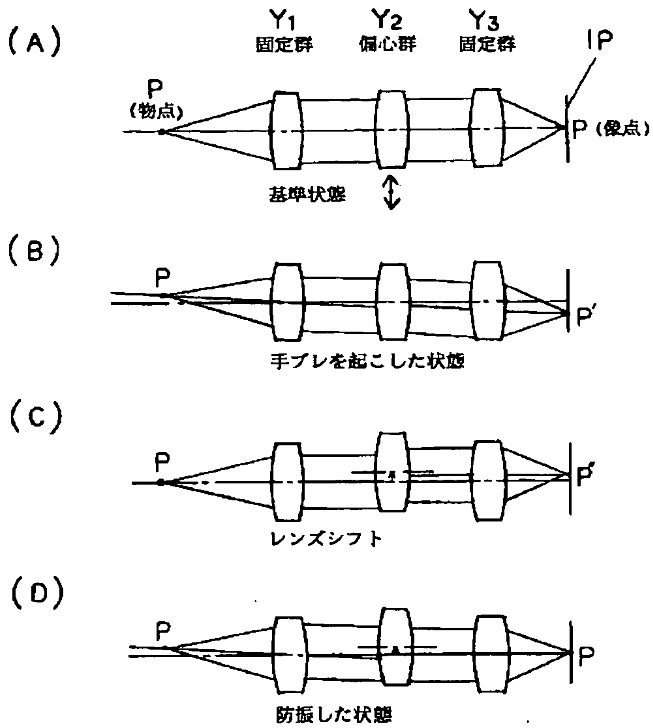

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報(A)　(11)特許出願公開番号

特開平7－128619

(43)公開日　平成7年(1995)5月19日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｇ０２Ｂ　27/64		9120－2K		
7/02	C			
13/18		9120－2K		
15/00		9120－2K		
15/16		9120－2K		

審査請求　未請求　請求項の数6　ＦＤ　（全 16 頁）　最終頁に続く

(21)出願番号　特願平5－298955

(22)出願日　平成5年(1993)11月4日

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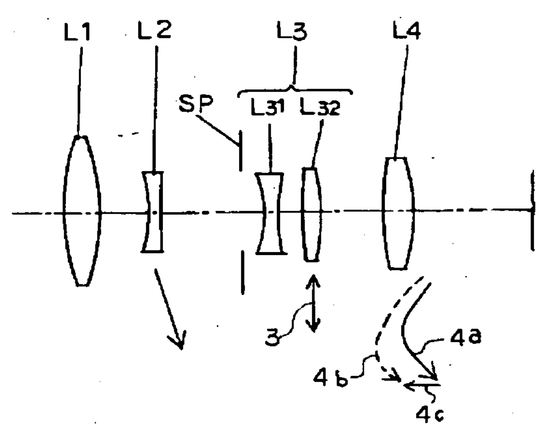
(54)【発明の名称】　防振機能を有した変倍光学系

(57)【要約】

【目的】　変倍光学系が振動したときの撮影画像のブレを光学的に補正して静止画像を得るようにした防振機能を有した変倍光学系を得ること。

【構成】　物体側より順に変倍及び合焦の際に固定の正の屈折力の第1群、変倍機能を有する負の屈折力の第2群、開口絞り、正の屈折力の第3群、そして変倍により変動する像面を補正する補正機能と合焦機能の双方の機能を有する正の屈折力の第4群の4つのレンズ群を有した変倍光学系であって、該第3群は負の屈折力の第31群と正の屈折力の第32群の2つのレンズ群より成り、該第32群を光軸と垂直方向に移動させて該変倍光学系が振動したときの撮影画像のブレを補正していること。



【特許請求の範囲】

【請求項１】　物体側より順に変倍及び合焦の際に固定の正の屈折力の第１群、変倍機能を有する負の屈折力の第２群、開口絞り、正の屈折力の第３群、そして変倍により変動する像面を補正する補正機能と合焦機能の双方の機能を有する正の屈折力の第４群の４つのレンズ群を有した変倍光学系であって、該第３群は負の屈折力の第３１群と正の屈折力の第３２群の２つのレンズ群より成り、該第３２群を光軸と垂直方向に移動させて該変倍光学系が振動したときの撮影画像のブレを補正していることを特徴とする防振機能を有した変倍光学系。

【請求項２】　前記第３１群と第３２群の焦点距離を各々ｆ３１，ｆ３２としたとき

$$1.5 < |f31/f32| < 2.5$$

なる条件を満足することを特徴とする請求項１の防振機能を有した変倍光学系。

【請求項３】　物体側より順に変倍及び合焦の際に固定の正の屈折力の第１群、変倍機能を有する負の屈折力の第２群、正の屈折力の第３群、そして変倍により変動する像面を補正する補正機能と合焦機能の双方の機能を有する正の屈折力の第４群の４つのレンズ群を有した変倍光学系であって、該第３群は複数のレンズ群を有し、該第３群中の少なくとも一部のレンズ群を光軸と垂直方向に移動させて該変倍光学系が振動したときの撮影画像のブレを補正していることを特徴とする防振機能を有した変倍光学系。

【請求項４】　前記第３群は正の屈折力の第３１群と負の屈折力の第３２群の２つのレンズ群を有し、該第３２群を光軸と垂直方向に移動させていることを特徴とする請求項３の防振機能を有した変倍光学系。

【請求項５】　前記第３１群と第３２群の焦点距離を各々ｆ３１，ｆ３２としたとき

$$0.8 < |f31/f32| < 1.0$$

なる条件を満足することを特徴とする請求項３の防振機能を有した変倍光学系。

【請求項６】　前記第３群の近傍に開口絞りを設けたことを特徴とする請求項３，４又は５の防振機能を有した変倍光学系。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は防振機能を有した変倍光学系に関し、特に変倍光学系の一部のレンズ群を光軸と垂直方向に移動させることにより、該変倍光学系が振動（傾動）したときの撮影画像のブレを光学的に補正して静止画像を得るようにし撮影画像の安定化を図った写真用カメラやビデオカメラ等に好適な防振機能を有した変倍光学系に関するものである。

【０００２】

【従来の技術】進行中の車や航空機等移動物体上から撮影をしようとすると撮影系に振動が伝わり手振れとなり撮影画像にブレが生じる。

【０００３】従来よりこのときの撮影画像のブレを防止する機能を有した防振光学系が種々と提案されている。

【０００４】例えば特公昭５６－２１１３３号公報では光学装置に振動状態を検知する検知手段からの出力信号に応じて、一部の光学部材を振動による画像の振動的変位を相殺する方向に移動させることにより画像の安定化を図っている。

【０００５】特開昭６１－２２３８１９号公報では最も被写体側に屈折型可変頂角プリズムを配置した撮影系において、撮影系の振動に対応させて該屈折型可変頂角プリズムの頂角を変化させて画像を偏向させて画像の安定化を図っている。

【０００６】特公昭５６－３４８４７号公報、特公昭５７－７４１４号公報等では撮影系の一部に振動に対して空間的に固定の光学部材を有し、この光学部材の振動に対して生ずるプリズム作用を利用することにより撮影画像を偏向させ結像面上で静止画像を得ている。

【０００７】特開平１－１１６６１９号公報や特開平２－１２４５２１号公報では加速度センサー等を利用して撮影系の振動を検出し、このとき得られる信号に応じ、撮影系の一部のレンズ群を光軸と直交する方向に振動させることにより静止画像を得る方法も行なわれている。

【０００８】この他、特開平２－２３８４２９号公報や米国特許第２９５９０８８号では負と正の屈折力の第１群と第２群の２つのレンズ群より成るレンズ系を撮影系の前方に配置し、撮影系が振動したとき、該第２群を防振用の稼動レンズ群とし、その焦点位置でジンバル支持した慣性振り子方式を利用した防振光学系を提案している。

【０００９】

【発明が解決しようとする課題】一般に防振光学系を撮影系の前方に配置し、該防振光学系の一部の可動レンズ群を振動させて撮影画像のブレを無くし、静止画像を得る方法は装置全体が大型化し、且つ該可動レンズ群を移動させる為の移動機構が複雑化してくるという問題点があった。

【００１０】又、可動レンズ群を振動させたときの偏心収差の発生量が多くなり光学性能が大きく低下してくるという問題点もあった。

【００１１】可変頂角プリズムを利用して防振を行なう光学系では特に長焦点距離側（望遠側）において防振時に偏心倍率色収差の発生量が多くなるという問題点があった。

【００１２】一方、撮影系の一部のレンズを光軸に対して垂直方向に平行偏心させて防振を行なう光学系においては、防振の為に特別な光学系は要しないという利点はあるが、移動させるレンズの為の空間を必要とし、又防振時における偏心収差の発生量が多くなってくるという問題点があった。

【0013】又、防振時において必要な光量を撮像面上で確保する為に可動レンズ群より物体側のレンズ群のレンズ径を大きくしなければならず、この為装置全体が大型化しくるという問題点があった。

【0014】本発明は、変倍光学系の一部を構成する比較的小型軽量のレンズ群を光軸と垂直方向に移動させて、該変倍光学系が振動（傾動）したときの画像のブレを補正するように構成することにより、装置全体の小型化，機構上の簡素化及び駆動手段の負荷の軽減化を図りつつ該レンズ群を偏心させたときの偏心発生量を少なく抑え、偏心収差を良好に補正した防振機能を有した変倍光学系の提供を目的とする。

【0015】

【課題を解決するための手段】本発明の防振機能を有した変倍光学系は、

（1－1）物体側より順に変倍及び合焦の際に固定の正の屈折力の第1群、変倍機能を有する負の屈折力の第2群、開口絞り、正の屈折力の第3群、そして変倍により変動する像面を補正する補正機能と合焦機能の双方の機能を有する正の屈折力の第4群の4つのレンズ群を有した変倍光学系であって、該第3群は負の屈折力の第31群と正の屈折力の第32群の2つのレンズ群より成り、該第32群を光軸と垂直方向に移動させて該変倍光学系が振動したときの撮影画像のブレを補正していることを特徴としている。

【0016】（1－2）物体側より順に変倍及び合焦の際に固定の正の屈折力の第1群、変倍機能を有する負の屈折力の第2群、正の屈折力の第3群、そして変倍により変動する像面を補正する補正機能と合焦機能の双方の機能を有する正の屈折力の第4群の4つのレンズ群を有した変倍光学系であって、該第3群は複数のレンズ群を有し、該第3群中の少なくとも一部のレンズ群を光軸と垂直方向に移動させて該変倍光学系が振動したときの撮影画像のブレを補正していることを特徴としている。

【0017】

【実施例】図1は本発明の後述する数値実施例1～4の近軸屈折力配置を示す概略図、図18，図19は本発明の後述する数値実施例5，6の近軸屈折力配置を示す概略図である。

【0018】図2～図5は本発明の数値実施例1～4の広角端のレンズ断面図、図20は本発明の数値実施例5の広角端のレンズ断面図である。

【0019】図1においてL1は正の屈折力の第1群、L2は負の屈折力の第2群、L3は正の屈折力の第3群であり、負の屈折力の第31群L31と正の屈折力の第32群L32とを有している。

【0020】数値実施例1～4では第32群L32を光軸と垂直方向に移動させて変倍光学系が振動（傾動）したときの撮影画像のブレを補正している。

【0021】L4は正の屈折力の第4群である。SPは開口絞りであり、第3群L3の前方に配置している。Gはフェースプレート等のガラスブロックである。IPは像面である。

【0022】本実施例では広角端から望遠端への変倍に際して矢印のように第2群を像面側へ移動させると共に、変倍に伴う像面変動を第4群を移動させて補正している。

【0023】又、第4群を光軸上移動させてフォーカスを行うリヤーフォーカス式を採用している。同図に示す第4群の実線の曲線4aと点線の曲線4bは各々無限遠物体と近距離物体にフォーカスしているときの広角端から望遠端への変倍に伴う際の像面変動を補正する為の移動軌跡を示している。尚、第1群と第3群は変倍及びフォーカスの際固定である。

【0024】本実施例においては第4群を移動させて変倍に伴う像面変動の補正を行うと共に第4群を移動させてフォーカスを行うようにしている。特に同図の曲線4a，4bに示すように広角端から望遠端への変倍に際して物体側へ凸状の軌跡を有するように移動させている。これにより第3群と第4群との空間の有効利用を図りレンズ全長の短縮化を効果的に達成している。

【0025】本実施例において、例えば望遠端において無限遠物体から近距離物体へフォーカスを行う場合は同図の直線4cに示すように第4群を前方へ繰り出すことにより行っている。

【0026】本実施例におけるズームレンズは第1群と第2群の合成系で形成した虚像を第3群と第4群で感光面上に結像するズーム方式をとっている。

【0027】本実施例では従来の所謂4群ズームレンズにおいて第1群を繰り出してフォーカスを行う場合に比べて前述のようなリヤーフォーカス方式を採ることにより第1群の偏心誤差による性能劣化を防止しつつ第1群のレンズ有効径の増大化を効果的に防止している。

【0028】そして開口絞りを第3群の直前に配置することにより可動レンズ群による収差変動を少なくし、開口絞りより前方のレンズ群の間隔を短くすることにより前玉レンズ径の縮少化を容易に達成している。

【0029】本発明の数値実施例1～4においては第3群L3を2つのレンズ群L3－1，L3－2より構成し、このうち第32群L32を防振用として光軸と垂直方向に移動させて変倍光学系が振動したときの像ブレを補正している。これにより従来の防振光学系に比べて防振の為のレンズ群や可変頂角プリズム等の光学部材を新たに付加することなく防振を行なっている。

【0030】次に本発明に係る変倍光学系においてレンズ群を光軸と垂直方向に移動させて撮影画像のブレを補正する防振系の光学的原理を図27を用いて説明する。

【0031】図27（A）に示すように光学系が固定群Y1・偏心群Y2そして固定群Y3の3つの部分から成り立っており、レンズから充分に離れた光軸上の物点P

が撮像面ＩＰの中心に像点ｐとして結像しているものとする。

【００３２】今、撮像面ＩＰを含めた光学系全体が図２７（Ｂ）のように手振れにより瞬間的に傾いたとすると、物点Ｐは像点ｐ′にやはり瞬間的に移動し、ブレた画像となる。

【００３３】一方、偏心群Ｙ２を光軸と垂直方向に移動させると図２７（Ｃ）のように、像点ｐはｐ″に移動し、その移動量・方向はパワー配置に依存し、そのレンズ群の偏心敏感度として表される。

【００３４】そこで図２７（Ｂ）で手振れによってズレた像点ｐ′を偏心群Ｙ２を適切な量だけ光軸と垂直方向に移動させることによってもとの結像位置ｐに戻すことで図２７（Ｄ）に示すとおり、手振れ補正つまり防振を行っている。

【００３５】今、画像をシフトするという意味での防振能力を防振敏感度ＩＳと呼ぶことにし、〔シフト量mm＊／補正角 ｄｅｇ〕という単位で表す。マスターレンズの焦点距離をｆ、シフト群Ｙ２の偏心敏感度をＴＳとすると防振敏感度ＩＳは

$$IS = f \cdot \tan 1^\circ / TS \quad \cdots\cdots \text{(a)}$$

で表され、そのシフト群のもつ偏心敏感度が重要なｆａｃｔｏｒとなってくる。

【００３６】本発明に係る変倍光学系では、通常第３群Ｌ３を出射した光は略平行光になっている。この為偏心敏感度ＴＳは非常に小さな値となっている。

【００３７】そこで本発明の数値実施例１～４においては第３群を負の屈折力の第３１群Ｌ３１と正の屈折力の第３２群Ｌ３２の２つのレンズ群で構成し、偏心敏感度ＴＳを大きくし、効果的に防振が行えるようにしている。

【００３８】特に数値実施例１～４においては第３１群と第３２群の焦点距離を夫々ｆ３１，ｆ３２としたとき

$$1.5 < | f31 / f32 | < 2.5 \quad \cdots\cdots (1-1)$$

を満足するようにしている。

【００３９】条件式（１－１）は第３群の２つのレンズ群の屈折力配置に関するものである。条件式（１－１）の上限値を越えて第３１群の負の屈折力が弱くなると、第３群を分割した効果が小さく、偏心敏感度が大きくとれないと共に、第３２群と第４群との間に第３２群を駆動手段を入れるスペースを確保するのが困難となり、好ましくない。

【００４０】逆に条件式（１－１）の下限値を越えて第３１群の負の屈折力が強くなり過ぎると、第３群を全体として正の屈折力に保つ為に第３２群の屈折力もそれに応じて強くなり過ぎ、防振時の光学性能劣化につながると共に第３２群の偏心敏感度が高くなり過ぎて防振制御の上からも各速度センサーからのブレ補正量を用いて閉ループ制御を行う場合に制御系の発振や補正残り等が出てきて好ましくない。

【００４１】次に本発明の数値実施例５，６について図１８，図１９を用いて説明する。

【００４２】数値実施例５，６は数値実施例１～４に比べて図１８に示すように正の屈折力の第３群を複数のレンズ群より構成し、このうち少なくとも１つのレンズ群Ｌ３ａを光軸と垂直方向に移動させて変倍光学系が振動（傾動）したときの撮影画像のブレを補正している点が異なっており、その他の構成は同じである。※

※【００４３】具体的には図１９に示すように第３群を物体側より順に正の屈折力の第３１群Ｌ３１と負の屈折力の第３２群Ｌ３２より構成し、該第３１群を光軸と垂直方向に移動させている点、第３１群と第３２群の焦点距離の比を制限する後述する条件式（１－２）が異なっており、その他の構成は同じである。

【００４４】図１８，図１９において図１と同じ要素には同符番を付している。

【００４５】図１９に示す近軸屈折力を有する数値実施例５，６の変倍光学系において撮影画像のブレを補正する防振系の光学的原理は基本的に前述した図２７と同じである。

【００４６】数値実施例５，６においては前述した数値実施例１～４と同様に第３群Ｌ３を出射した光束が略平行光になるように設定されている。この為第３群Ｌ３の偏心敏感度は非常に小さな値となっている。

【００４７】そこで数値実施例５，６においては図１９に示すように第３群Ｌ３を正の屈折力の第３１群と負の屈折力の第３２群とに分割し、これにより第３１群の偏心敏感度を高め、効果的に防振が行えるようにしている。

【００４８】又数値実施例５，６においては第３１群と第３２群の焦点距離を夫々ｆ３１，ｆ３２としたとき

$$0.8 < | f31 / f32 | < 1.0 \quad \cdots\cdots (1-2)$$

を満足するようにしている。

【００４９】条件式（１－２）は第３群を構成するレンズ群の屈折力配分に関するものであり、条件式（１－２）の下限値を越えて第３２群の負の屈折力が弱くなると第３群を分割した効果が小さく、偏心敏感度を大きく取れない。

【００５０】逆に条件式（１－２）の上限値を越えて第３２群の負の屈折力が強くなりすぎると第３群を全体として正の屈折力に保つ為に第３１群の正の屈折力もそれに応じて強くなりすぎ、防振時の性能劣化につながると共に第３１群の偏心敏感度が高くなり過ぎて防振制御の点からも、例えば手振れ量検出手段から得られる信号を用いて閉ループ制御を行った場合に制御系の発振を招いたり、ブレの補正残り等が生じて好ましくない。

【0051】尚、数値実施例1～4では第31群を両レンズ面が凹面の負の単一レンズ又は物体側に凸面を向けたメニスカス上の正レンズと負レンズの2つのレンズより構成し、第32群を正レンズ、正レンズと負レンズを接合した貼り合わせレンズより構成している。

【0052】又数値実施例5，6では第31群を正レンズと負レンズを接合した貼合わせレンズ、正レンズより構成し、第32群を2つの負レンズより構成している。

【0053】これにより防振用のレンズ群を光軸と垂直方向に移動させたときの偏心収差の発生を少なくし、画面全体の光学性能を良好に維持している。

【0054】次に本発明の数値実施例を示す。数値実施例においてRiは物体側より順に第i番目のレンズ面の曲率半径、Diは物体側より第i番目のレンズ厚及び空気間隔、Niとνiは各々物体側より順に第i番目のレンズのガラスの屈折率とアッベ数である。又前述の各条件式と数値実施例における諸数値との関係を表－1に示す。

【0055】非球面形状は光軸方向にX軸、光軸と垂直方向にH軸、光の進行方向を正としRを近軸曲率半径、A，B，C，D，Eを各々非球面係数としたとき

【0056】

【数1】

$$X=\frac{(1/R)H^2}{1+\sqrt{1-(H/R)^2}}+AH^2+BH^4+CH^6+DH^8+EH^{10}$$

なる式で表している。

【0057】〈数値実施例1〉

F= 1.0 ～10.0　fno=1:1.85 ～2.28　2ω=46.81° ～6.08°

R 1= 17.935	D 1= 0.304	N 1=1.80518	ν 1= 25.4
R 2= 4.321	D 2= 1.673	N 2=1.62299	ν 2= 58.2
R 3= -16.760	D 3= 0.043		
R 4= 3.684	D 4= 0.956	N 3=1.72000	ν 3= 50.3
R 5= 9.957	D 5= 可変		
R 6= -62.802	D 6= 0.108	N 4=1.77250	ν 4= 49.6
R 7= 0.975	D 7= 0.541		
R 8= -3.053	D 8= 0.108	N 5=1.69680	ν 5= 55.5
R 9= 1.075	D 9= 0.608	N 6=1.84666	ν 6= 23.8
R10=-682.845	D10= 可変		
R11= (絞り)	D11= 0.434		
R12= -6.171	D12= 0.130	N 7=1.60311	ν 7= 60.7
R13= 5.553	D13= 0.434		
R14= 4.532	D14= 0.717	N 8=1.60311	ν 8= 60.7
R15= -2.632	D15= 0.032		
R16= 3.554	D16= 0.978	N 9=1.60311	ν 9= 60.7
R17= -1.752	D17= 0.152	N10=1.83481	ν10= 42.7
R18=-308.466	D18= 可変		
R19= 56.092	D19= 0.108	N11=1.80518	ν11= 25.4
R20= 2.492	D20= 0.760	N12=1.48749	ν12= 70.2
R21= -2.787	D21= 0.032		
R22= 2.430	D22= 0.391	N13=1.48749	ν13= 70.2
R23= 7.801	D23= 0.500		
R24= ∞	D24= 0.869	N14=1.51633	ν14= 64.2
R25= ∞			

【0058】

【表1】

焦点距離 可変間隔	1.00	10.00
D 5	0.40	3.49
D10	3.25	0.15
D18	1.07	1.07

〈数値実施例2〉

F= 1.0 ～10.0　fno=1:1.85 ～2.23　2ω=46.81° ～6.08°

R 1= 21.740	D 1= 0.304	N 1=1.76182	ν 1= 26.5
R 2= 4.446	D 2= 1.673	N 2=1.62299	ν 2= 58.2
R 3= -14.968	D 3= 0.043		
R 4= 3.948	D 4= 0.956	N 3=1.72000	ν 3= 50.3
R 5= 11.376	D 5= 可変		
R 6= -11.640	D 6= 0.108	N 4=1.77250	ν 4= 49.6
R 7= 1.111	D 7= 0.541		
R 8= -2.765	D 8= 0.108	N 5=1.69680	ν 5= 55.5
R 9= 1.058	D 9= 0.608	N 6=1.80518	ν 6= 25.4
R10= -29.905	D10= 可変		
R11= (絞り)	D11= 0.434		
R12= -5.327	D12= 0.130	N 7=1.63854	ν 7= 55.4
R13= 7.093	D13= 0.434		
R14= 5.505	D14= 0.717	N 8=1.60311	ν 8= 60.7
R15= -2.490	D15= 0.032		
R16= 3.611	D16= 0.978	N 9=1.60311	ν 9= 60.7
R17= -1.840	D17= 0.152	N10=1.83481	ν10= 42.7
R18= -85.956	D18= 可変		
R19= 11.631	D19= 0.108	N11=1.80518	ν11= 25.4
R20= 2.097	D20= 0.760	N12=1.48749	ν12= 70.2
R21= -4.162	D21= 0.032		
R22= 2.593	D22= 0.391	N13=1.48749	ν13= 70.2
R23= -9.836	D23= 0.500		
R24= ∞	D24= 0.869	N14=1.51633	ν14= 64.2
R25= ∞			

【0059】

【表2】

焦点距離 可変間隔	1.00	10.00
D 5	0.42	3.51
D10	3.24	0.15
D18	2.23	2.23

〈数値実施例3〉

F= 1.0 ～10.0　fno=1:1.85 ～2.21　2ω=46.81° ～6.08°

R 1= 15.031	D 1= 0.304	N 1=1.76182	ν 1= 26.5
R 2= 4.611	D 2= 1.673	N 2=1.62299	ν 2= 58.2
R 3= -18.629	D 3= 0.043		
R 4= 4.007	D 4= 0.956	N 3=1.72000	ν 3= 50.3
R 5= 10.750	D 5= 可変		
R 6= 6.050	D 6= 0.108	N 4=1.77250	ν 4= 49.6
R 7= 1.276	D 7= 0.541		
R 8= -1.788	D 8= 0.108	N 5=1.72000	ν 5= 50.3
R 9= 1.718	D 9= 0.608	N 6=1.80518	ν 6= 25.4
R10= 133.160	D10= 可変		
R11= (絞り)	D11= 0.434		
R12= 3.170	D12= 0.326	N 7=1.60311	ν 7= 60.7
R13= 7.281	D13= 0.434		
R14= -2.365	D14= 0.217	N 8=1.67003	ν 8= 47.3
R15= 29.731	D15= 0.434		

R16= 16.013	D16= 0.717	N 9=1.60311	ν 9= 60.7
R17= -2.343	D17= 0.032		
R18= 2.923	D18= 0.978	N10=1.60311	ν10= 60.7
R19= -3.358	D19= 0.152	N11=1.83481	ν11= 42.7
R20= 12.068	D20= 可変		
R21= 2.456	D21= 0.108	N12=1.80518	ν12= 25.4
R22= 1.441	D22= 0.760	N13=1.51823	ν13= 59.0
R23= -9.081	D23= 0.532		
R24= ∞	D24= 0.869	N14=1.51633	ν14= 64.2
R25= ∞			

【0060】
【表3】

焦点距離 可変間隔	1.00	10.00
D 5	0.12	3.21
D10	3.48	0.38
D20	1.93	1.93

16面非球面
R=16.0134 B=-1.117×10^{-2} C=2.083×10^{-3} D=-3.291×10^{-4}

（数値実施例4）

F= 1.0 ～10.43 fno=1:1.85 ～2.40 2ω=46.50° ～5.77°

R 1= 12.084	D 1= 0.301	N 1=1.76182	ν 1= 26.5
R 2= 4.096	D 2= 1.505	N 2=1.62299	ν 2= 58.2
R 3= -26.777	D 3= 0.043		
R 4= 3.671	D 4= 0.881	N 3=1.72000	ν 3= 50.3
R 5= 10.066	D 5= 可変		
R 6= 5.701	D 6= 0.107	N 4=1.77250	ν 4= 49.6
R 7= 1.251	D 7= 0.531		
R 8= -2.085	D 8= 0.107	N 5=1.69680	ν 5= 55.5
R 9= 1.831	D 9= 0.172		
R10= 2.270	D10= 0.344	N 6=1.84666	ν 6= 23.8
R11= 10.584	D11= 可変		
R12= (絞り)	D12= 0.236		
R13= 2.920	D13= 0.322	N 7=1.60311	ν 7= 60.7
R14= 5.774	D14= 0.430		
R15= -2.972	D15= 0.215	N 8=1.67003	ν 8= 47.3
R16= 6.906	D16= 0.430		
R17= 16.531	D17= 0.709	N 9=1.60311	ν 9= 60.7
R18= -2.237	D18= 0.032		
R19= 2.479	D19= 0.967	N10=1.60311	ν10= 60.7
R20= -3.320	D20= 0.150	N11=1.83481	ν11= 42.7
R21= 9.208	D21= 可変		
R22= 2.544	D22= 0.107	N12=1.80518	ν12= 25.4
R23= 1.367	D23= 0.752	N13=1.51823	ν13= 59.0
R24= -5.274	D24= 0.526		
R25= ∞	D25= 0.860	N14=1.51633	ν14= 64.2
R26= ∞			

【0061】
【表4】

焦点距離 可変間隔	1.00	10.43
D 5	0.19	3.06
D11	3.19	0.32
D21	1.79	2.10

17面非球面

R=16.5318　B=-1.128 $\times 10^{-2}$　C=2.125 $\times 10^{-3}$　D=-3.738$\times 10^{-4}$

〈数値実施例5〉

F= 1.0 ～10.18　fno=1:1.8～2.25　2ω=55.6 ° ～5.92°

R 1= 8.932	D 1= 0.236	N 1=1.84666	ν 1= 23.8
R 2= 4.170	D 2= 1.204	N 2=1.60311	ν 2= 60.7
R 3= -49.973	D 3= 0.032		
R 4= 3.835	D 4= 0.795	N 3=1.77250	ν 3= 49.6
R 5= 12.046	D 5= 可変		
R 6= 7.960	D 6= 0.107	N 4=1.77250	ν 4= 49.6
R 7= 1.103	D 7= 0.442		
R 8= -1.982	D 8= 0.107	N 5=1.69680	ν 5= 55.5
R 9= 2.079	D 9= 0.172		
R10= 2.454	D10= 0.258	N 6=1.84666	ν 6= 23.8
R11= 160.589	D11= 可変		
R12= (絞り)	D12= 0.236		
R13= 1.757	D13= 0.602	N 7=1.58313	ν 7= 59.4
R14= -2.854	D14= 0.129	N 8=1.84666	ν 8= 23.8
R15= -4.161	D15= 0.032		
R16= 2.815	D16= 0.258	N 9=1.60311	ν 9= 60.7
R17= 18.352	D17= 0.172		
R18= 5.662	D18= 0.129	N10=1.60342	ν10= 38.0
R19= 1.169	D19= 0.236		
R20= -5.533	D20= 0.129	N11=1.51633	ν11= 64.2
R21= 12.496	D21= 可変		
R22= 3.322	D22= 0.107	N12=1.84666	ν12= 23.8
R23= 1.783	D23= 0.000		
R24= 1.779	D24= 0.322	N13=1.48749	ν13= 70.2
R25= -8.758	D25= 0.018		
R26= 2.175	D26= 0.301	N14=1.60311	ν14= 60.7
R27= -10.557	D27= 0.645		
R28= ∞	D28= 0.860	N15=1.51633	ν15= 64.2
R29= ∞			

【0062】

【表5】

焦点距離 可変間隔	1.00	10.18
D 5	0.19	3.07
D11	3.16	0.28
D21	0.82	1.07

13面非球面

R= 1.7576　B=-4.007 $\times 10^{-2}$　C=1.864 $\times 10^{-3}$　D=-4.671$\times 10^{-3}$

〈数値実施例6〉

F= 1.0 〜10.42　fno=1:1.8〜2.3　2ω=55.6 ° 〜5.79°

R 1= 9.321	D 1= 0.236	N 1=1.84666	ν 1= 23.8
R 2= 4.266	D 2= 1.204	N 2=1.60311	ν 2= 60.7
R 3= -38.473	D 3= 0.032		
R 4= 3.737	D 4= 0.795	N 3=1.77250	ν 3= 49.6
R 5= 10.774	D 5= 可変		
R 6= 8.094	D 6= 0.107	N 4=1.77250	ν 4= 49.6
R 7= 1.121	D 7= 0.443		
R 8= -2.024	D 8= 0.107	N 5=1.69680	ν 5= 55.5
R 9= 2.043	D 9= 0.172		
R10= 2.423	D10= 0.258	N 6=1.84666	ν 6= 23.8
R11= 52.455	D11= 可変		
R12= (絞り)	D12= 0.236		
R13= 2.321	D13= 0.602	N 7=1.58313	ν 7= 59.4
R14= -2.491	D14= 0.129	N 8=1.84666	ν 8= 23.8
R15= -3.290	D15= 0.032		
R16= 3.422	D16= 0.258	N 9=1.60311	ν 9= 60.7
R17= -11.800	D17= 0.172		
R18= 5.676	D18= 0.129	N10=1.60342	ν10= 38.0
R19= 1.430	D19= 0.236		
R20= -3.884	D20= 0.129	N11=1.51633	ν11= 64.2
R21= 6.793	D21= 可変		
R22= 3.792	D22= 0.107	N12=1.84666	ν12= 23.8
R23= 1.789	D23= 0.000		
R24= 1.769	D24= 0.430	N13=1.48749	ν13= 70.2
R25= -6.116	D25= 0.032		
R26= 2.504	D26= 0.365	N14=1.60311	ν14= 60.7
R27= -6.668	D27= 0.645		
R28= ∞	D28= 0.860	N15=1.51633	ν15= 64.2
R29= ∞			

【0063】
【表6】

焦点距離 可変間隔	1.00	10.42
D 5	0.18	3.06
D11	3.16	0.28
D21	1.21	1.47

13面非球面
R= 2.321　B=-3.742 $\times 10^{-2}$　C=3.089 $\times 10^{-3}$　D=-2.166$\times 10^{-3}$

【0064】
＊　＊【表7】

表−1

条件式	数値実施例					
	1	2	3	4	5	6
(1-1) |f31/f32|	2.06	2.00	2.37	2.32	——	——
(1-2) |f31/f32|	——	——	——	——	0.95	0.92

【0065】
【発明の効果】本発明によれば以上のように、変倍光学系の一部を構成する比較的小型軽量のレンズ群を光軸と垂直方向に移動させて、該変倍光学系が振動（傾動）し

たときの画像のブレを補正するように構成することにより、装置全体の小型化，機構上の簡素化及び駆動手段の負荷の軽減化を図りつつ該レンズ群を偏心させたときの偏心発生量を少なく抑え、偏心収差を良好に補正した防振機能を有した変倍光学系を達成することができる。

【図面の簡単な説明】

【図1】　本発明に係る変倍光学系の近軸屈折力配置の概略図

【図2】　本発明の数値実施例１の広角端のレンズ断面図

【図3】　本発明の数値実施例２の広角端のレンズ断面図

【図4】　本発明の数値実施例３の広角端のレンズ断面図

【図5】　本発明の数値実施例４の広角端のレンズ断面図

【図6】　本発明の数値実施例１の広角端の諸収差図

【図7】　本発明の数値実施例１の望遠端の諸収差図

【図8】　本発明の数値実施例１の望遠端の諸収差図

【図9】　本発明の数値実施例２の広角端の諸収差図

【図１０】　本発明の数値実施例２の望遠端の諸収差図

【図１１】　本発明の数値実施例２の望遠端の諸収差図

【図１２】　本発明の数値実施例３の広角端の諸収差図

【図１３】　本発明の数値実施例３の望遠端の諸収差図

【図１４】　本発明の数値実施例３の望遠端の諸収差図

【図１５】　本発明の数値実施例４の広角端の諸収差図

【図１６】　本発明の数値実施例４の望遠端の諸収差図

【図１７】　本発明の数値実施例４の望遠端の諸収差図

【図１８】　本発明に係る変倍光学系の近軸屈折力配置の概略図

【図１９】　本発明に係る変倍光学系の近軸屈折力配置の概略図

【図２０】　本発明の数値実施例５の広角端のレンズ断面図

【図２１】　本発明の数値実施例５の広角端の諸収差図

【図２２】　本発明の数値実施例５の望遠端の諸収差図

【図２３】　本発明の数値実施例５の望遠端の諸収差図

【図２４】　本発明の数値実施例６の広角端の諸収差図

【図２５】　本発明の数値実施例６の望遠端の諸収差図

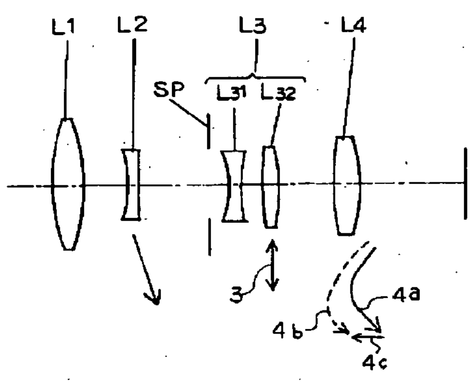
【図２６】　本発明の数値実施例６の望遠端の諸収差図

【図２７】　本発明に係る防振系の光学的原理の説明図

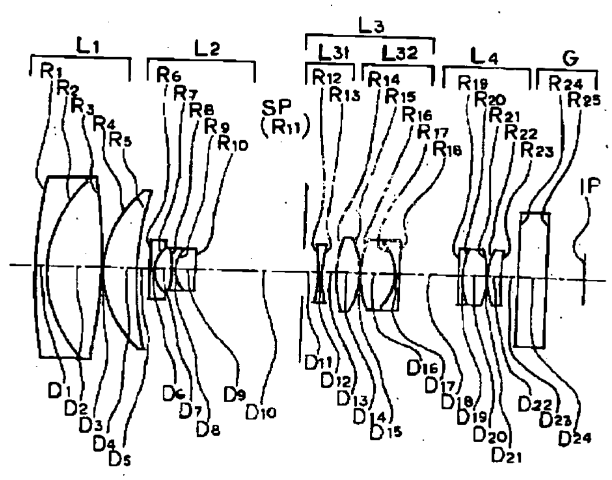
【符号の説明】

Ｌ１	第１群
Ｌ２	第２群
Ｌ３	第３群
Ｌ４	第４群
Ｌ３１	第３１群
Ｌ３２	第３２群
ＳＰ	絞り
ＩＰ	像面
d	d線
g	g線
ΔＭ	メリディオナル像面
ΔＳ	サジタル像面

【図1】



【図2】



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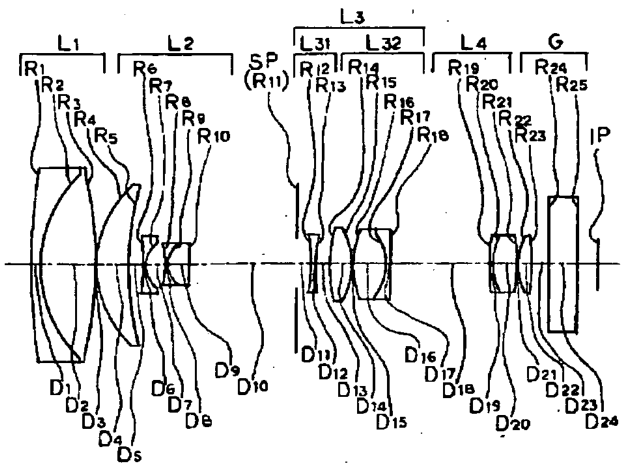

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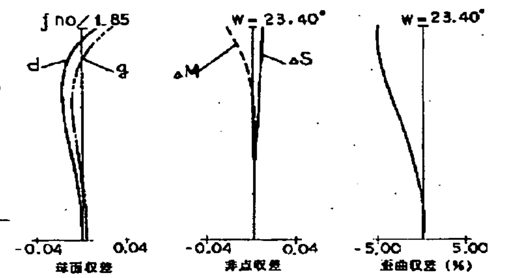
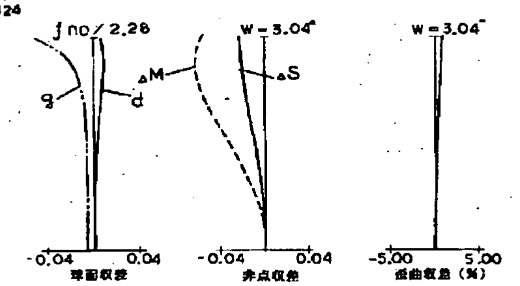


【図7】



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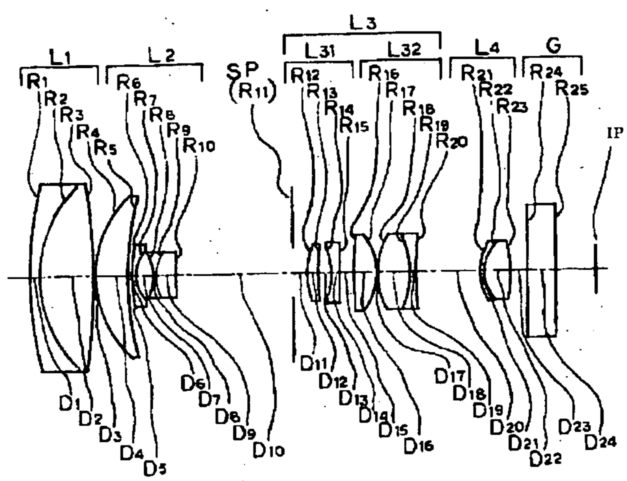
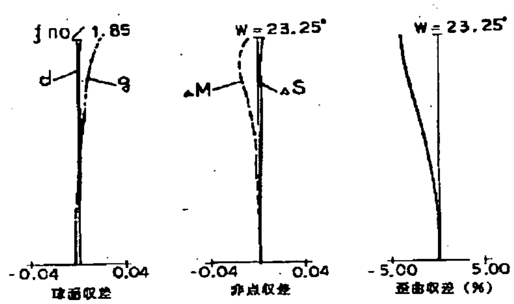
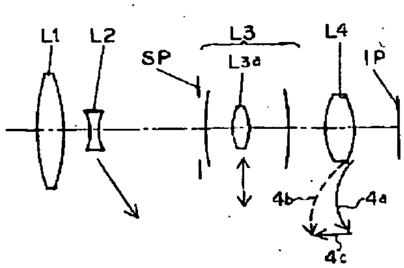


【図15】



【図18】



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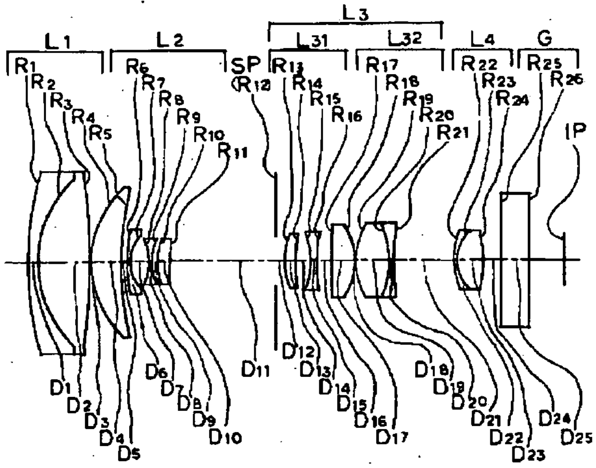

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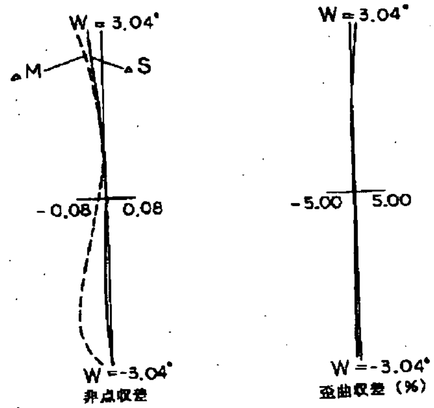
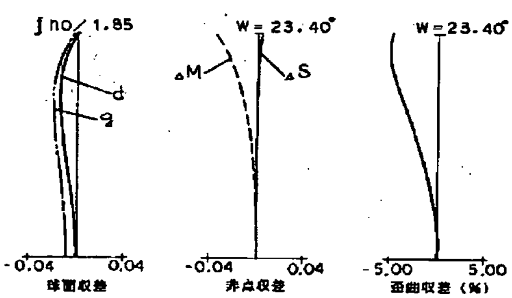


【図9】



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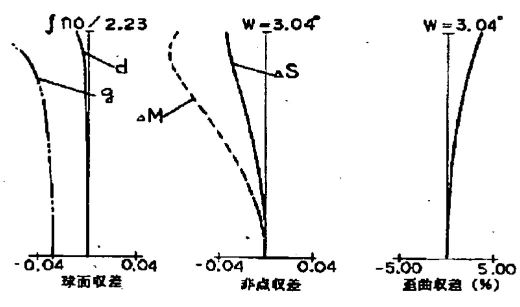

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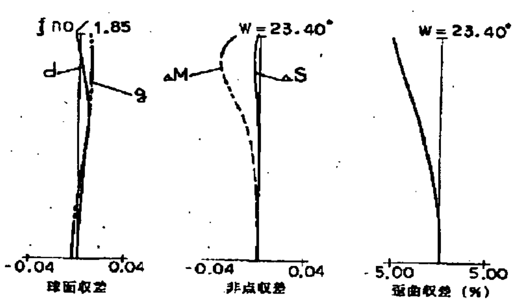
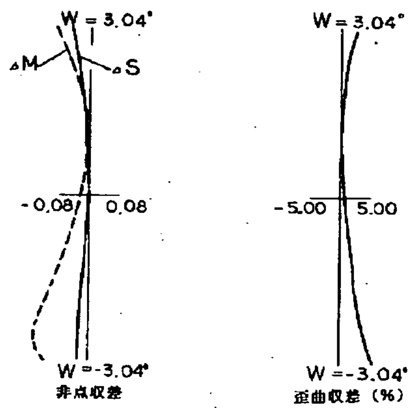
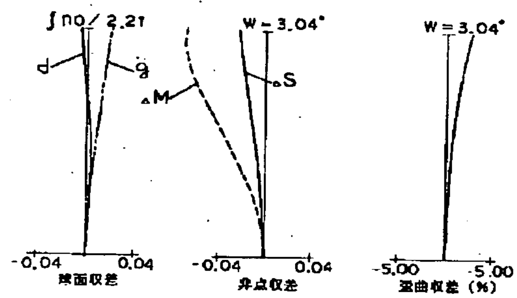


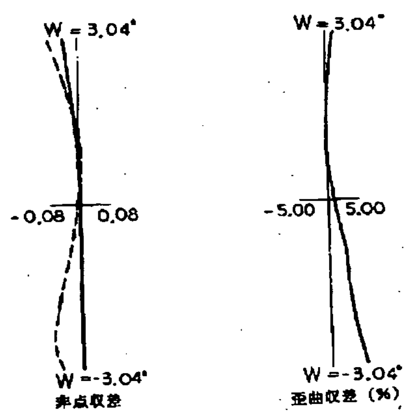
【図１１】



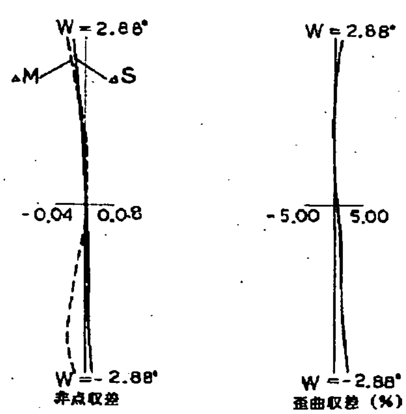
【図１３】



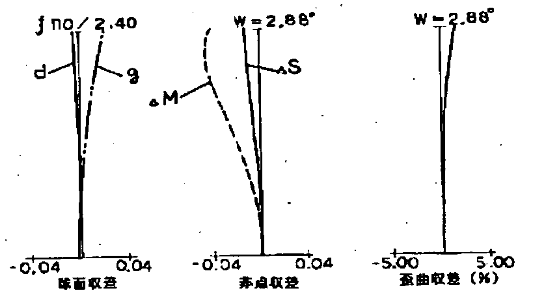
【図１４】



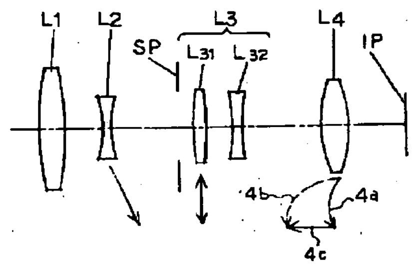
【図１７】



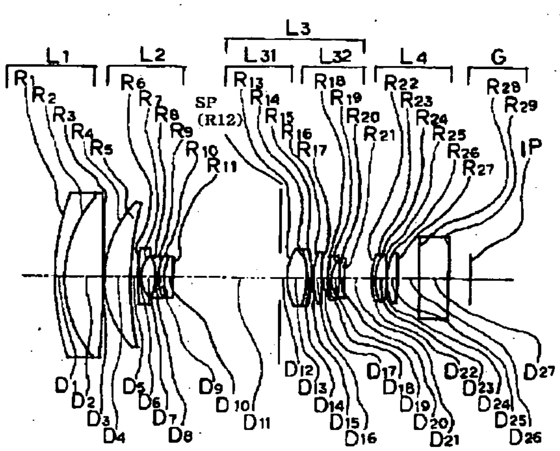
【図１６】



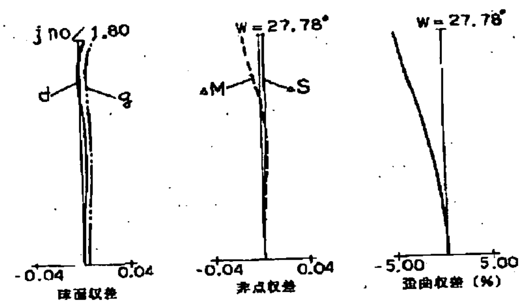
【図１９】



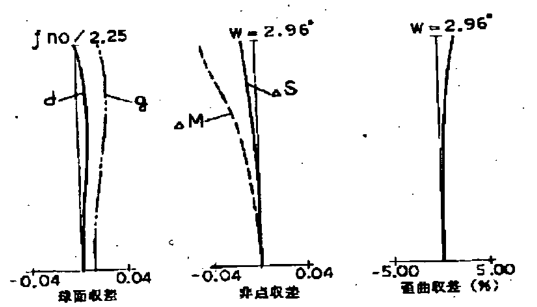
【図２０】



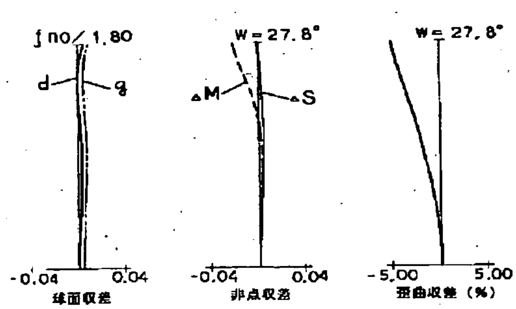
【図２１】



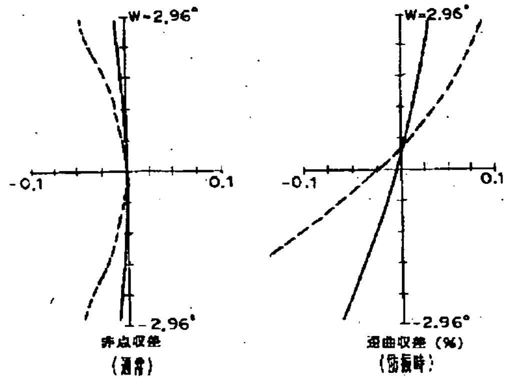
【図２２】



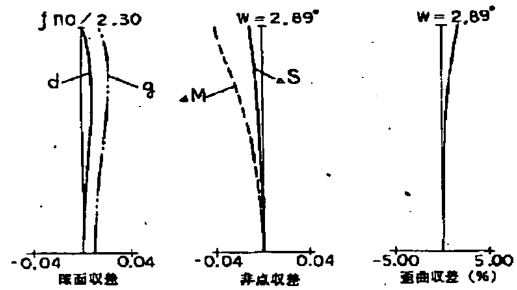
【図２４】



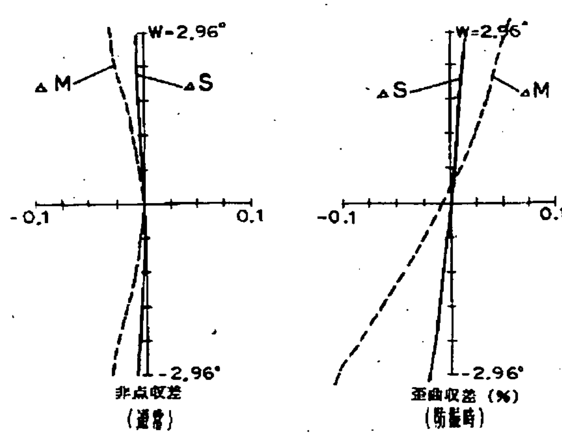
【図２３】


W=2.96°
-0.1
0.1
-2.96°
非点収差
(通常)
W=2.96°
-0.1
0.1
-2.96°
歪曲収差 (%)
(防振時)

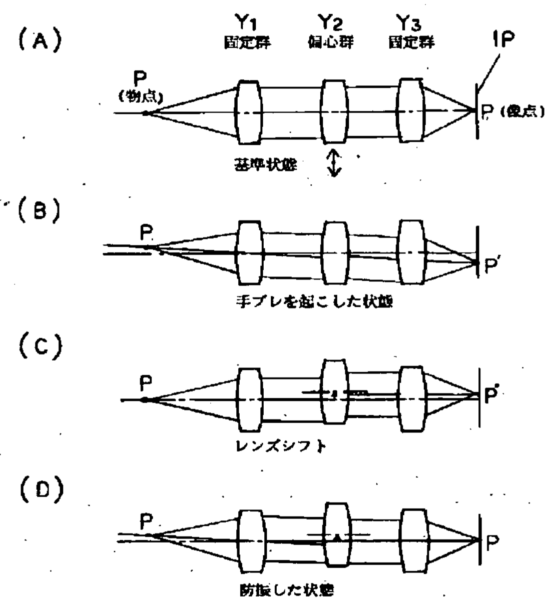
【図２５】


fno/2.30
d
g
-0.04
0.04
球面収差
W=2.89°
M
S
-0.04
0.04
非点収差
W=2.89°
-5.00
5.00
歪曲収差 (%)

【図２６】


W=2.96°
M
S
-0.1
0.1
-2.96°
非点収差
(通常)
W=2.96°
S
M
-0.1
0.1
-2.96°
歪曲収差 (%)
(防振時)

【図27】



フロントページの続き

(51) Int.Cl.⁶	識別記号	庁内整理番号	F I	技術表示箇所
G 0 3 B　5/00	J	7513－2K		